*Apollo*â
Multi-Function Display
Model MX20

Installation Manual

UPS Aviation Technologies SM

A subsidiary of United Parcel Service

HISTORY OF REVISIONS

Revision	Date	Description
--	11/1/1999	Initial Release
01	11/11/1999	Updated installation package contents and equipment mounting information.
02	1/17/2000	Added the MX20 configuration procedure, expanded post installation checkout procedures, added Appendix A.

ORDERING INFORMATION

To receive additional copies of this publication, order part # **560-1025,** *Apollo MX20 Multi-Function Display Installation Manual*.

OTHER PUBLICATIONS

GX50/60 Installation Manual, P/N 560-0959
WX-500 Installation Manual, BF Goodrich Aerospace P/N 009-11500-001

End User License Agreement ("EULA")

Refund. If you do not agree to the terms of this EULA, UPS Aviation Technologies and Microsoft are unwilling to license the MX20 and its Operating System to you. In such event, you may not use or copy the Licensed Product, and you should promptly contact UPS Aviation Technologies for instructions on return of the unused product(s) for a refund.

Client Access Licenses. If you use the MX20 Operating System to access or utilize the services or functionality of Microsoft Windows NT Server (all editions) or use the MX20 Operating System to permit workstation or computing devices to access or utilize the services or functionality of Microsoft Windows NT Server, you may be required to obtain a Client Access License for the MX20 Operating System and/or each such workstation or computing device.

No Warranties. Except as expressly provided in the limited warranty section, the MX20 and its operating system are provided to you "as is" without warranty of any kind, either expressed or implied, including, but not limited to, warranties of noninfringement, merchantability, and/or fitness for a particular purpose. The entire risk of the quality and performance of the software is with the user.

No Liability for Consequential Damages. UPS Aviation Technologies and/or UPS Aviation Technologies' software suppliers shall not be held liable for any damages suffered or incurred by you (including, but not limited to, general, special, consequential or incidental damages including damages for loss of business profits, business interruption, loss of business information and the like), arising from or in connection with the delivery, use, or performance of the software.

Customer Remedies. UPS Aviation Technologies' and UPS Aviation Technologies suppliers' entire liability and your exclusive remedy shall be, at UPS Aviation Technologies' option, either (a) return of the price paid, or (b) repair or replacement of the MX20 and its operating system that does not meet the above Limited Warranty and which is returned to UPS Aviation Technologies with a copy of your receipt. This Limited Warranty is void if failure of the MX20 or its operating system has resulted from accident, abuse, or misapplication. Any replacement MX20 and its operating system will be warranted for the remainder of the original warranty period or thirty (30) days, whichever is longer.

Limitations on Reverse Engineering, Decompilation and Disassembly. You may not reverse engineer, decompile, or disassemble the MX20 or its operating system, except and only to the extent that such activity is expressly permitted by applicable law notwithstanding this limitation.

Separation of Components. The MX20 and its operating system are licensed as a single product. Its component parts may not be separated for use on more than one MX20.

Single Embedded System. The MX20 and its operating system are licensed with the MX20 as a single integrated product. The MX20 operating system may only be used with the MX20 as set forth in these licensing terms.

U.S. Government Restricted Rights Legend: This Software is furnished with Restricted Rights. Use, duplication, or disclosure of the Software by the U.S. Government is subject to the restrictions as set forth in subparagraph (c)(1)(ii) of the Rights in Technical Data and Computer Software clause at 48 C.F.R. Sec. 252.227-7013 or in subparagraphs (c)(1) and (2) of the Commercial Computer Software-Restricted Rights clause at 48 C.F.R. Sec. 52-227-19, as applicable. UPS Aviation Technologies, 2345 Turner Road S.E., Salem, OR 97302.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

NOTES

1 INTRODUCTION

1.1 ABOUT THIS MANUAL

This manual describes the installation of the Apollo MX20 Multi-Function Display. It is intended for use by persons certified by the Federal Aviation Administration (FAA) to install aircraft navigation devices. It includes installation and checkout procedures for the MX20 to standards described in FAA advisory circular AC 20-138.

| Section 1 | Provides an **introduction** to the MX20. TSO certification information is also included in this section. |

| Section 2 | Includes **installation** and checkout procedures. |

| Section 3 | Includes complete **specifications**. |

| Section 4 | Includes **troubleshooting** information. |

| Section 5 | Includes **continued airworthiness instructions** requirements. |

| Section 7 | Includes the **environmental qualification form**. |

1.2 SYSTEM DESCRIPTION

The MX20 is a multi-function display capable of displaying Moving Maps, Terrain Awareness information and VFR/IFR charting functions. An optional datalink provides ADS-B traffic and FIS uplink to the MX20 display. Interfacing to the WX-500 provides lightning strike information and display. The MX20 display is also available with an internal GPS. The internal GPS position source permits a Navigation Uncertainty Category (NUC) value to be calculated and transmitted for ADS-B broadcast. The MX20 must be connected to an external GPS navigation source to provide route and flight plan information. The MX20 must be connected to an external serial altitude source to provide terrain awareness information.
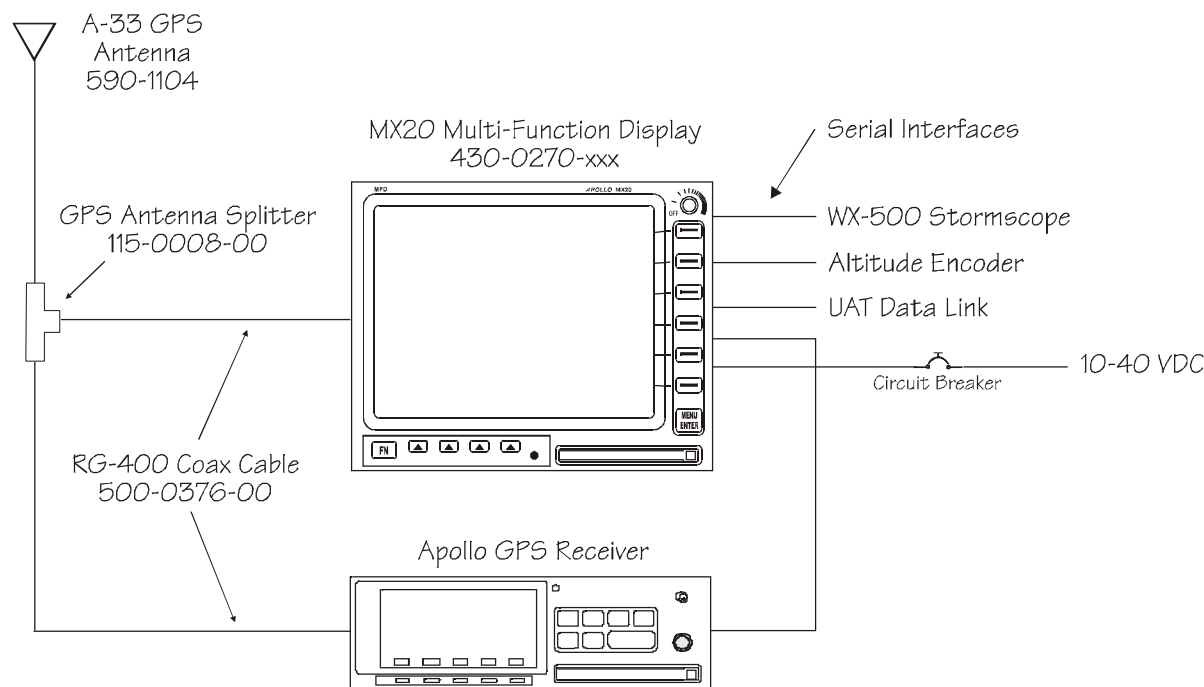
Figure 1 - MX20 System Block Diagram
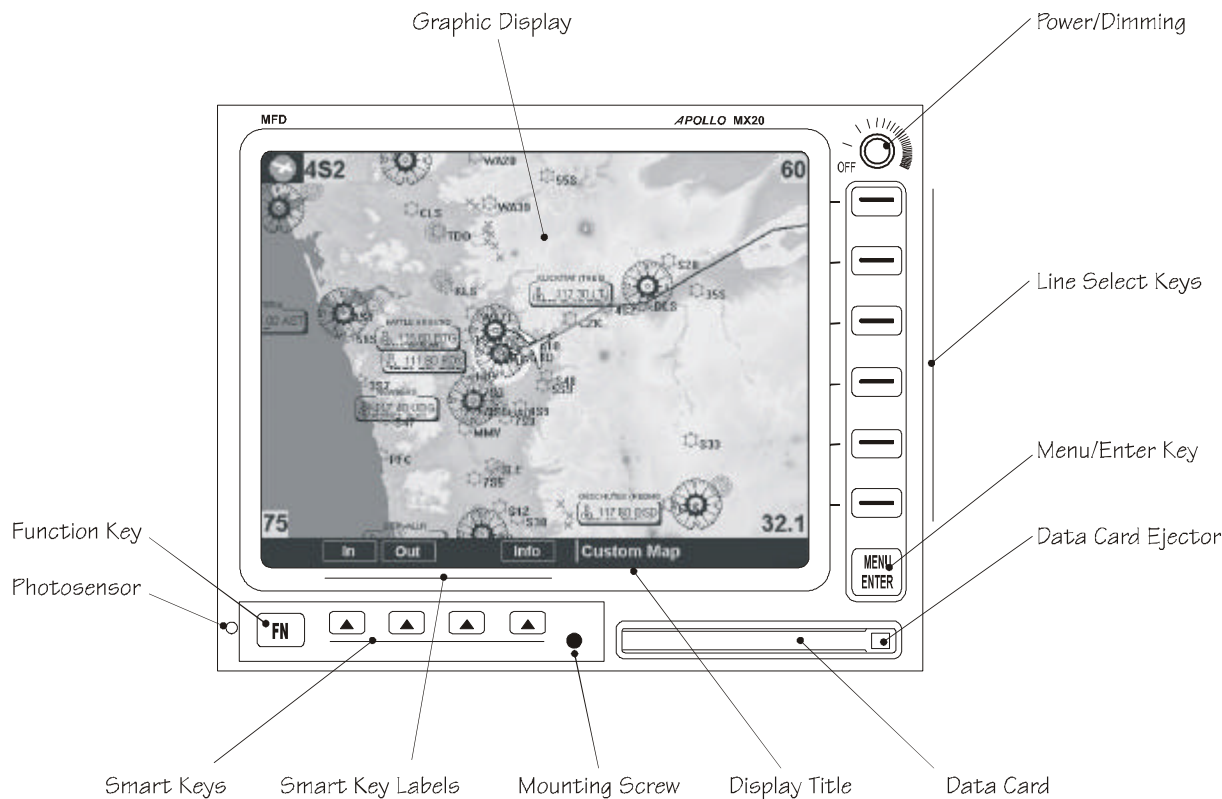
Figure 2 - MX20 Front Panel Description

1.3 REGULATORY COMPLIANCE

The MX20 is designed and tested to meet the following TSOs:
   FAA TSO-C110a (when connected to BFG WX500)
   FAA TSO-C113

The MX20 software is designed and tested to RTCA/DO-178B, levels C and D.

Note: Unauthorized changes or modifications to the MX20 will void the compliance to required regulatory agencies and authorization for continued equipment usage.

1.4 UNPACKING THE EQUIPMENT

Carefully unpack the equipment. Visually inspect the package contents for any evidence of shipping damage. Retain all shipping containers and packaging material in case reshipment is necessary.

1.5 PACKAGE CONTENTS

As shipped from the UPS Aviation Technologies factory, the MX20 Installation package includes most necessary items for installation other than supplies normally available at the installation shop. The items included in the package are listed in Table 1.

Table 1 - Installation Package Contents			
Part #	Description	Quantity w/o GPS 424-0751-000	Quantity w/ GPS
Unit			
430-0270-000	Apollo MX20 Multifunction Display with GPS		1
430-0270-500	Apollo MX20 Multifunction Display without GPS	1	
	MX20 Installation Kit		
115-0007-00	GPS 1575 MHz 2:1 splitter		1
162-1008	Right angle coax plug		1
162-1060	TNC Connector		3
162-1577* or 162-0103**	37-pin d-Sub	1	1
202-0001	Cable tie	4	4
204-0037	Edge grommet	6"	6"
204-2100	Shoulder bushing		2
220-0637	6-32 Wing nut	1	1
240-0615	#6 Washer	2	2
224-0404	4-40 x 1/4 SS flat head Phillips machine screw	2	2
245-0027* or 245-0022**	Crimp contact for d-sub, 20 to 24 AWG wire	30	30
310-0429-00	MFD Mounting Tube	1	1
998-0048	3/32" hex driver	1	1
564-0076-000	**Manual Kit**	**1**	**1**
560-1025	MX20 Installation Guide	1	1

Table 1 - Installation Package Contents			
Part #	Description	Quantity w/o GPS 424-0751-000	Quantity w/ GPS
560-1026	MX20 User's Guide	1	1
561-0263	MX20 Quick Reference Guide	1	1
564-0077-000	STC Kit (AFM & MDL)	1	1

Notes:
   *   Pin has a barrel over the contact. Use ITT Cannon tools.
   ** Pin has a bare, split contact. Use Astro Tool Corp. tools.			

1.6 OTHER REQUIRED MATERIALS

The MX20 equipment is intended for use with standard aviation accessories. The following items are required for the installation:

- Position locating source, such as: Apollo GX50/55/60/65 GPS receiver
- Serial Altitude Encoder

1.7 SPECIAL TOOLS REQUIRED

Crimp Tool
A crimp tool meeting MIL specification M22520/1-01 and a positioner/locator are required to ensure consistent, reliable crimp contact connections for the rear d-sub connectors. These tools are available from:

For pin P/N 245-0027

    ITT Cannon   Phone (714) 261-5300
    1851 E. Deere Ave.   Fax   (714) 575-8324
    Santa Ana, CA 92705-6500

    Insertion tool: ITT part # 274-7006-000 (Desc. CIET-20HD)
    Regular duty Crimp tool: ITT part # 995-0001-585 (Desc. M22520/1-01)
    Regular duty Locator tool: ITT part # 995-0001-244 (Desc. TH25)
    Heavy duty Crimp tool: ITT part # 995-0001-584 (Desc. M22520/2-01)
    Heavy duty Locator tool: ITT part # 995-0001-604 (Desc. M22520/2-08)

For pin P/N 245-0022

    Astro Tool Corp   Phone (503) 642-9853
    21615 SW TV Highway   Fax   (503) 591-7766
    Beaverton, OR 97006

    Crimp tool: Astro Tool part # 615708
    Positioner: Astro Tool part # 616356

1.8 LICENSE REQUIREMENTS

There are no license requirements for the MX20.

1.9 OPERATING INSTRUCTIONS

1.9.1 MX20

The MX20 User's Guide, UPS Aviation Technologies P/N 560-1026, covers operation and pilot interface. The MX20 Quick Reference Guide is P/N 561-0263.

NOTES

2 INSTALLATION

This section describes the installation of the MX20 including mounting, wiring, connections, and software configuration. A post-installation checkout procedure is included at the end of this section.

2.1 PRE-INSTALLATION INFORMATION

Always follow good avionics installation practices per FAA Advisory Circulars (AC) 43.13-1B, 43.13-2A, and AC 20-130A, or later FAA approved revisions of these documents.

Follow the installation procedure in this section as it is presented for a successful installation. Read the entire section before beginning the procedure. Prior to installation, consider the structural integrity of the MX20 installation as defined in AC 43.13.2A, Chapter 1. Perform the post installation checkout before closing the work area in case problems occur.

Complete an electrical load analysis in accordance with AC 43.13-1B, Chapter 11, on the aircraft prior to starting modification to ensure aircraft has the ability to carry the MX20 load. Refer to Section 2.5.1 for the power consumption of each MX20 mode of operation (heater on). Document the results of the electrical load analysis on FAA Form 337.

2.2 INSTALLATION OVERVIEW

A successful installation should start with careful planning including determination of mounting location for the MX20, cable routing, and other required modifications. Once the mounting location has been determined, prepare the mounting frames for installation. It may be easier to complete the wiring harness and attach the connectors to the mounting frame before installing the mounting frame.

Carefully plan which external devices are to be connected to which MX20 ports observing the special characteristics of ports 3 and 4.

2.3 INSTALLATION CONSIDERATIONS

2.3.1 MOUNTING CONSIDERATIONS

The MX20 is designed to mount in the avionics stack in the aircraft instrument panel within view and reach of the pilot. The MX20 must be located where the operator will have easy access to the controls and adequate viewing of the display. Sample diagrams of typical cockpit front panel views of the MX20 are shown in Figure 3 and Figure 4.

The standard package includes a mounting frame for ease of mounting, connections, and service of the unit. Allow an additional one-inch clearance to the rear of the mounting frame for connectors and cables. Mounting frame details are shown in Figure 5, Figure 6, Figure 7, and Figure 8.

The MX20 does not require external cooling. When mounting the MX20, leave a clearance of 1/8 to 1/4 inch between avionics to allow for circulation.
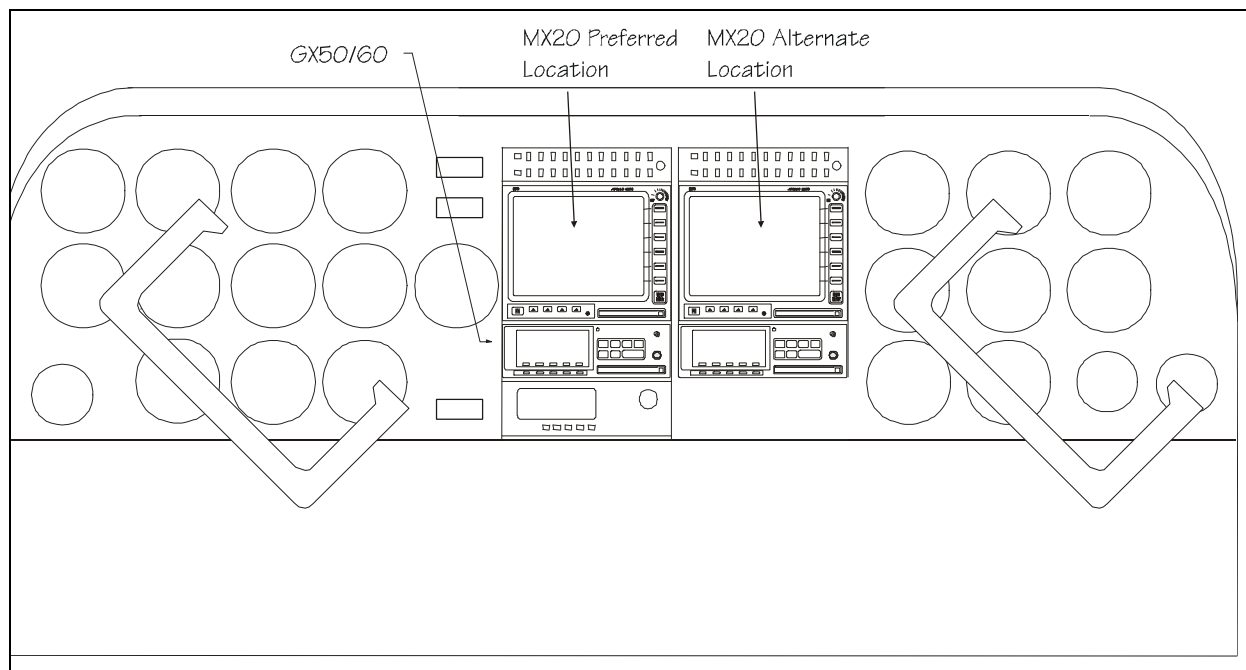
Figure 3 - Cockpit Panel Configuration for a Large Panel
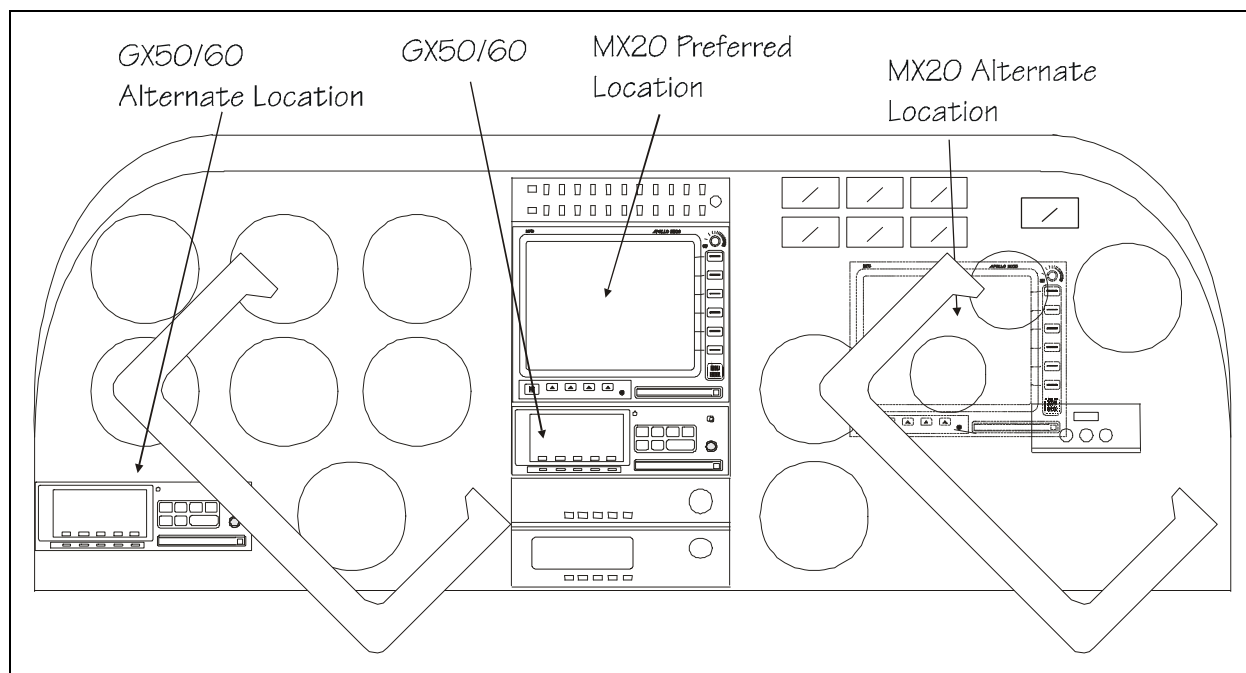
Figure 4 - Cockpit Panel Configuration for a Small Panel

6-32 LOCK NUT

6-32 x ½
Flat Head Screw
AN507

MOUNTING TUBE
P/N 310-0429-00

INSTRUMENT PANEL

SECURED TO VERTICAL
SUPPORT AT THIS POINT
8 PLACES EACH SIDE MAX.

REAR VIEW

SIDE VIEW
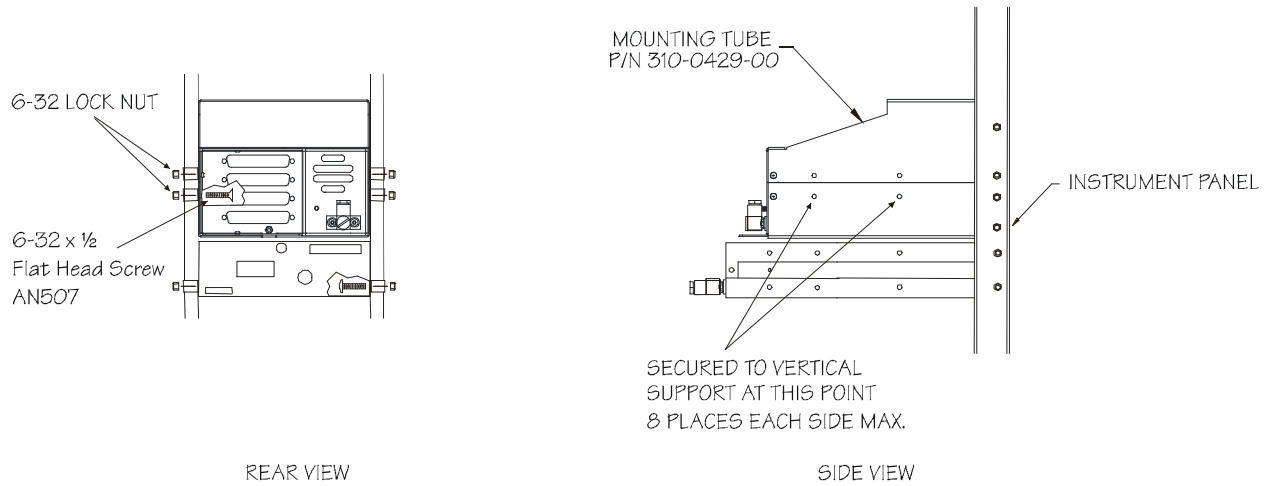
Figure 5 - Sample GX60 & MX20 Mounting
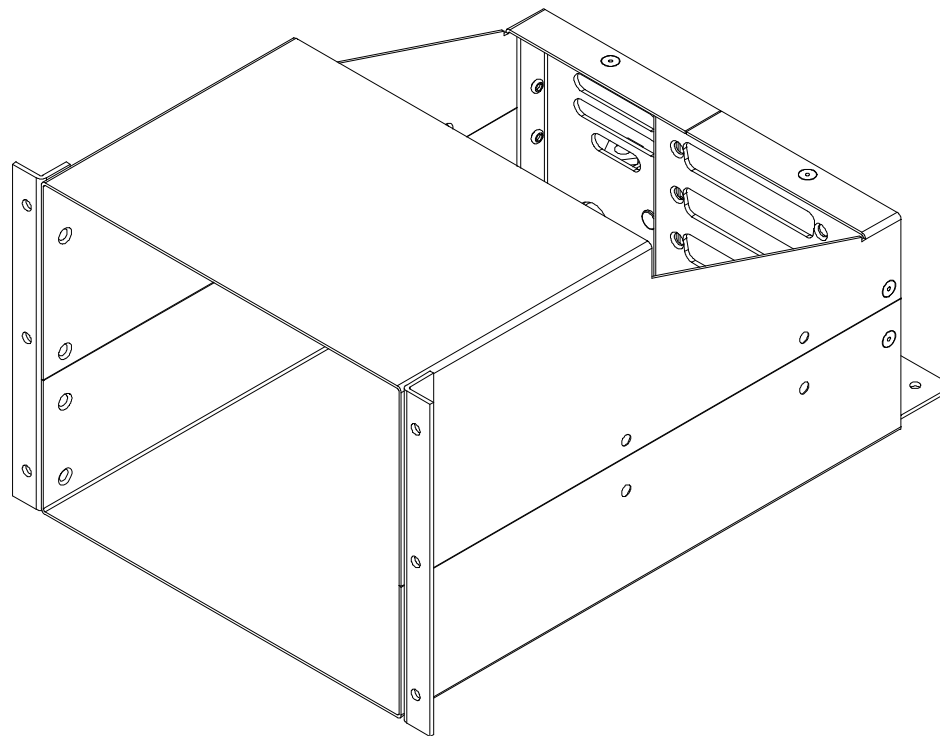
Figure 6 - Alternate MX20 Mounting Configuration

> *Note: This configuration utilizes an* L *bracket along each side of the mounting tube. It will mount against the instrument panel.*

Top View

Front View

Side View

Rear View

6.250"

5.000"

9.632"

8.721"
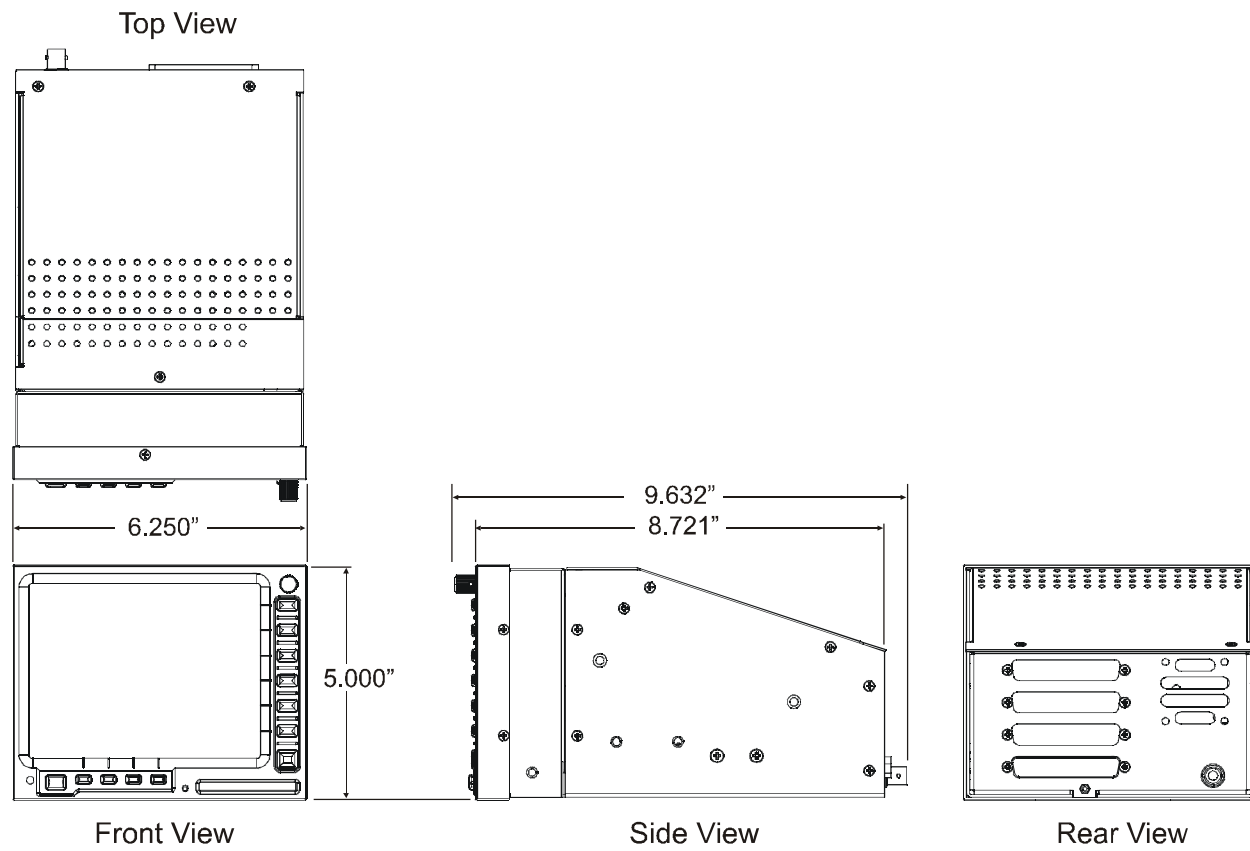
Figure 7 - MX20 Unit Dimensions

Top View

9.720"

6.250"

5.000"

9.632"

4.351"

Front View   Side View   Rear View
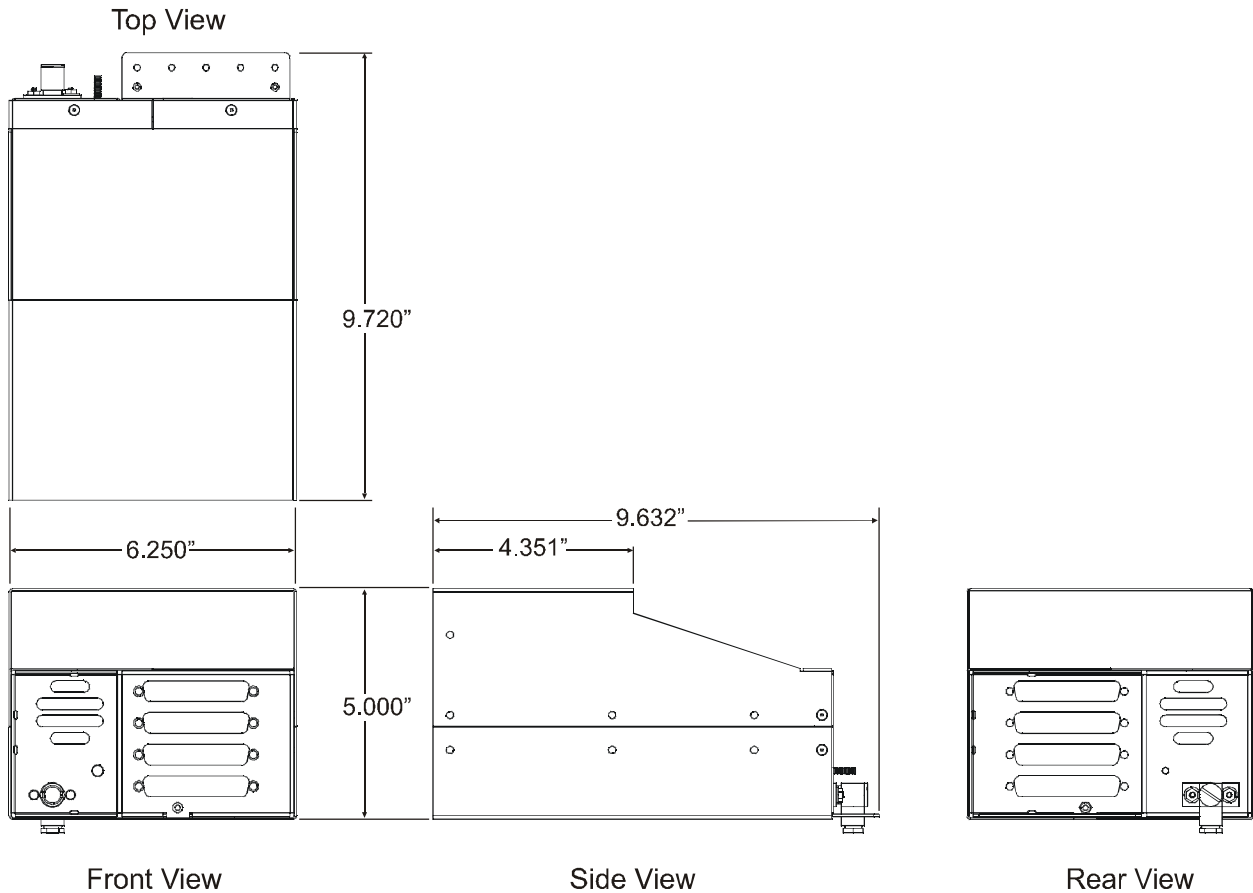
Figure 8 - MX20 Mounting Tube Assembly Dimensions

2.3.2 MINIMUM SYSTEM CONFIGURATION

The MX20 requires connections to the following equipment as a minimum, as appropriate for each unit:

- Power input
- Serial position input device (such as the Apollo GX60, or equivalent)
- Serial altitude encoder

The serial I/O requirements are located in Appendix A of this manual.

2.3.3 AIR CIRCULATION

No external cooling is required for the MX20.

2.3.4 COMPASS SAFE DISTANCE

After reconfiguring the avionics in the cockpit panel, if the MX20 is mounted less than 4" from the compass, recalibrate the compass and make the necessary changes for noting correction data.

2.3.5 VIEWING ANGLE

The MX20 shall be located such that the operator will have easy access to the controls and have adequate view of the display. The MX20 may be adequately viewed from the primary pilot's position when the following minimums are met:

Up:	20 degrees off center line
Down:	30 degrees off center line
Right:	50 degrees off center line
Left:	50 degrees off center line

2.4 EQUIPMENT MOUNTING

Once the cable assemblies have been made, attach each connector to the rear connector mounting plate and the mounting tube as illustrated in Figure 9. Route the wiring bundle as appropriate.

Use tie wraps to secure the cable to the rear connector plate to provide strain relief for the cable assembly as shown in View A of Figure 9. Connect the shield grounds directly to the grounding lug.

Mounting Tube
Secure the mounting tube to the instrument panel structure using a maximum of 16 screws. The AN507 6-32 screws have a 100° countersink head. The mating holes in the instrument panel structure must also be countersunk to accept the screw head so that the screw head is flush with the inside surface of the mounting tube.

CAUTION

Failure to properly countersink the mounting holes will result in damage to the MX20. Mounting screw heads must not protrude into the mounting tube.

An alternate mounting configuration can be accomplished using locally-fabricated *L* brackets. Make the brackets from 20-24 T3 aluminum, 0.040", and form a 90° bend. When attaching the *L* brackets to the mounting tube, screw heads must not protrude into the mounting tube.
Once the cable assemblies are complete and the connectors are attached to the mounting frame, install the mounting frame assembly in the instrument panel. Be sure to use AN507 flat head screws so the unit will slide in and out freely. Attach the front of the mounting frame to the instrument panel. Use support brackets to attach the rear of the frame to the aircraft. Cable wiring to the mounting frame is shown in Figure 9.

Slide the unit into the frame and tighten the threaded screw shaft using the 3/32" hex driver provided in the installation package. The unit will be pulled into the frame by the shaft and the connectors will fully engage.

To remove the unit from the mounting frame, unscrew the screw shaft. The unit will be loosened and then may be pulled from the frame. No special extraction tools are required.

4-40 X ¼ Flat
Head Screw (2x)

Mounting Tube

Washer (2x)

Edge Guard (3x)

RA Coax
Plug*

37-Pin
D-sub

Wingnut

See View A

GPS Antenna*

Shoulder
Bushing (2x)*

*GPS Installations Only

View A
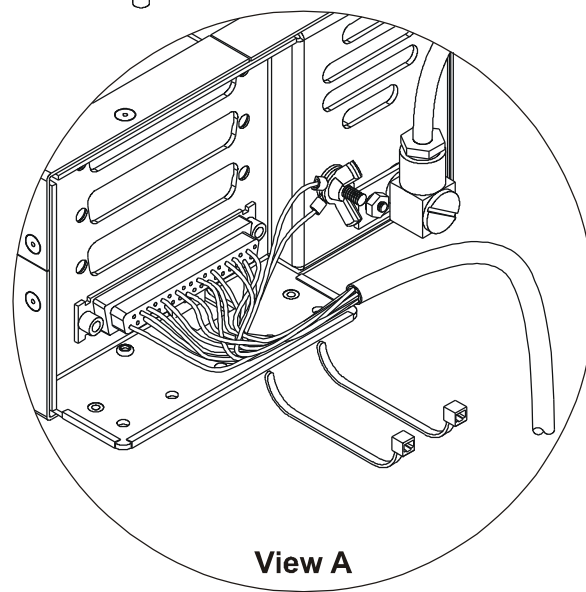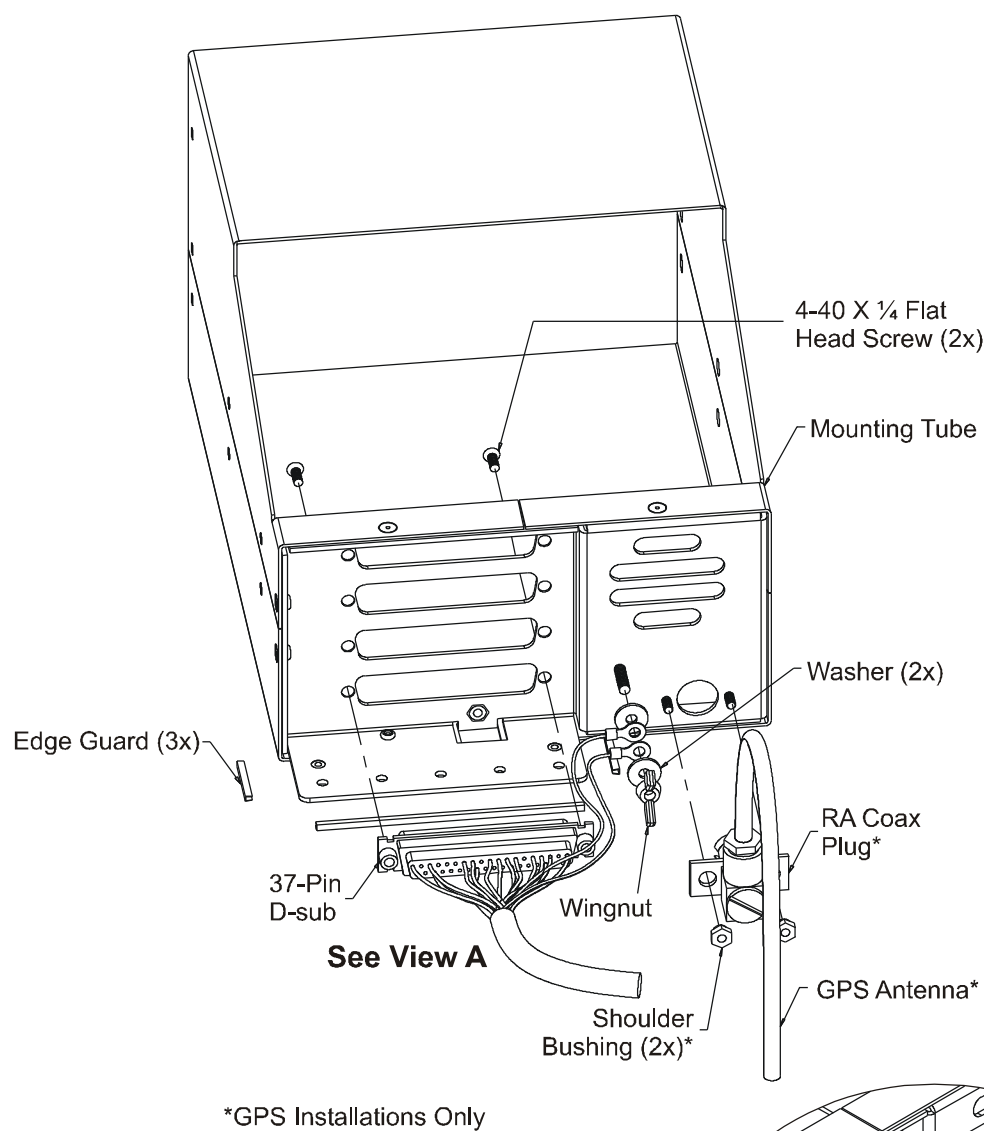
Figure 9 - MX20 Rear Panel Wiring Connections

2.5 ELECTRICAL CONNECTIONS

The MX20 installation kit includes connectors and crimp contacts. The crimp contacts are specified for 20 to 24 AWG wire. Make the crimp connections with a crimp tool as specified in the Special Tools Required section on page 4. All wires should be 20 to 24 AWG unless otherwise specified. Shield grounds should be connected to the grounding lug on the back of the chassis. Wiring shall be in accordance with AC 43.13-1B.

2.5.1 DATA PORT CONFIGURATION

The MX20 supports four I/O ports. Three of the ports are RS232 and one is RS422. The usage of each port is assigned during the software setup procedure. The diagram below provides an example of a configuration for the data ports. A sample of a typical wiring configuration is shown in Figure 12.

Note that the software must be configured to match the MX20 wiring configuration.

Table 2 - Preferred Data Port Configurations			
		With GPS	**Without GPS**
PORT 1	RS232	GX50/60	GX50/60 or equivalent
PORT 2	RS232	Altitude Encoder	Altitude Encoder
PORT 3	RS232	Internal GPS*	Future upgrade
PORT 4	RS422	UAT Datalink Radio or option	WX-500 or option

∗   If the MX20 is configured with an internal GPS engine, Port 3 is not available for external connections.
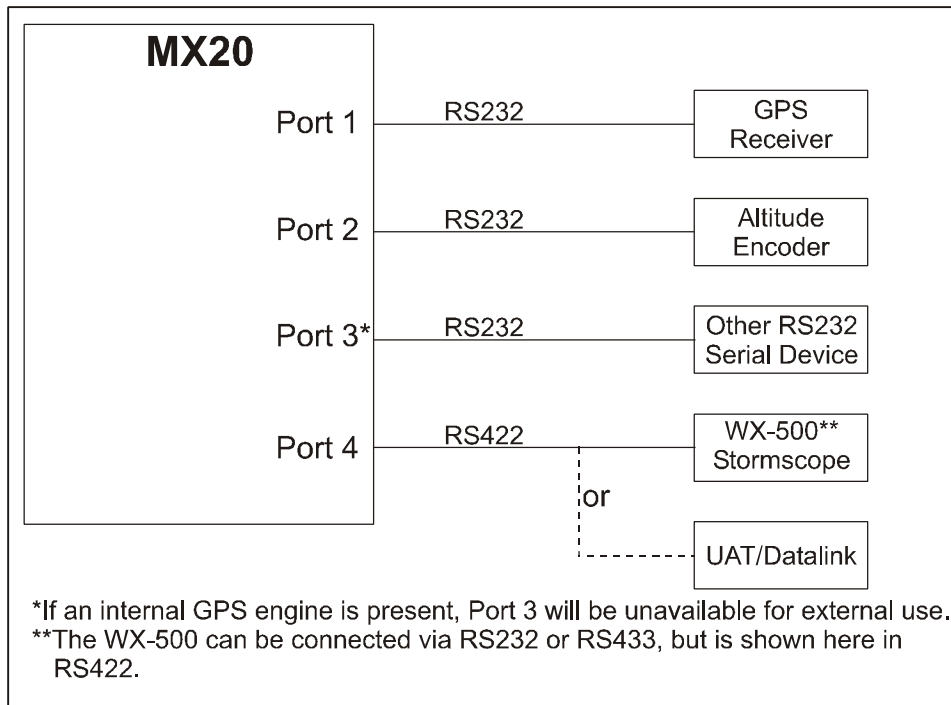
Figure 10 – Preferred Data Port Description

2.5.2 DATA CARD

The data card is a Compact Flash™ card that contains the NAV database, operating software, and other information. The data card is required for MX20 operation.

2.5.3 PLACARD

A VFR limitation placard is required in all MX20 installations. A placard stating "GPS and MFD limited to VFR use only" is provided in the installation kit. If the GPS installation is approved for IFR, trim the words "GPS and" from the placard and place the placard prominently on or near the MX20 unit. Placard the circuit breaker as appropriate.

2.5.4 POWER

The power and fuse requirements for each unit are described in their respective installation manuals. The MX20 will operate on voltages between 10 and 40 VDC. Install a 5 amp circuit breaker for a 14 VDC aircraft and a 2 amp circuit breaker for a 28 VDC aircraft. Use two separate wires for the heater and CPU power inputs; one wire to each pin.

2.5.5 ELECTRICAL LOAD ANALYSIS

An electrical load analysis should be completed on each aircraft prior to installation in accordance with AC 43.13-1B, Chapter 11. Use the following values for computation:

Table 3 – Unit Power Loads				
Unit	14 VDC		28 VDC	
	Typical	Max	Typical	Max
MX20	2.0 A	3.0 A	1 A	1.5 A
MX20 with heater [(1)]	3.0 A	4.0 A	1.5 A	2.0 A
Notes: 1. Heater element turns on below 10°C.				

Note: *Circuits should be protected in accordance with guidelines in AC 43.13-1B, chapter 11, section 2, paragraph 429. Power inputs should be across a minimum of all four specified input pins.*
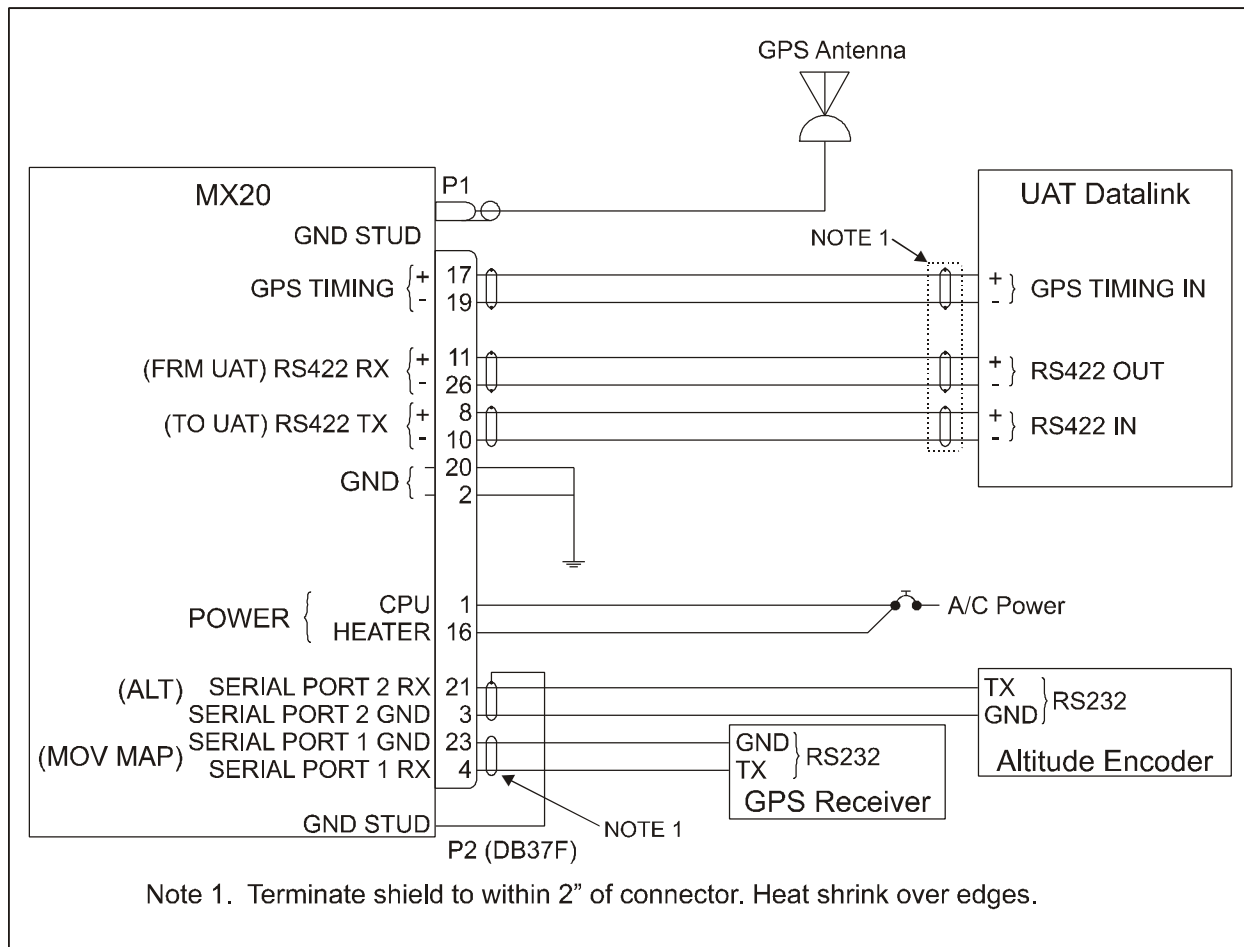
Figure 11 - Sample System Wiring Diagram (Internal GPS Version)
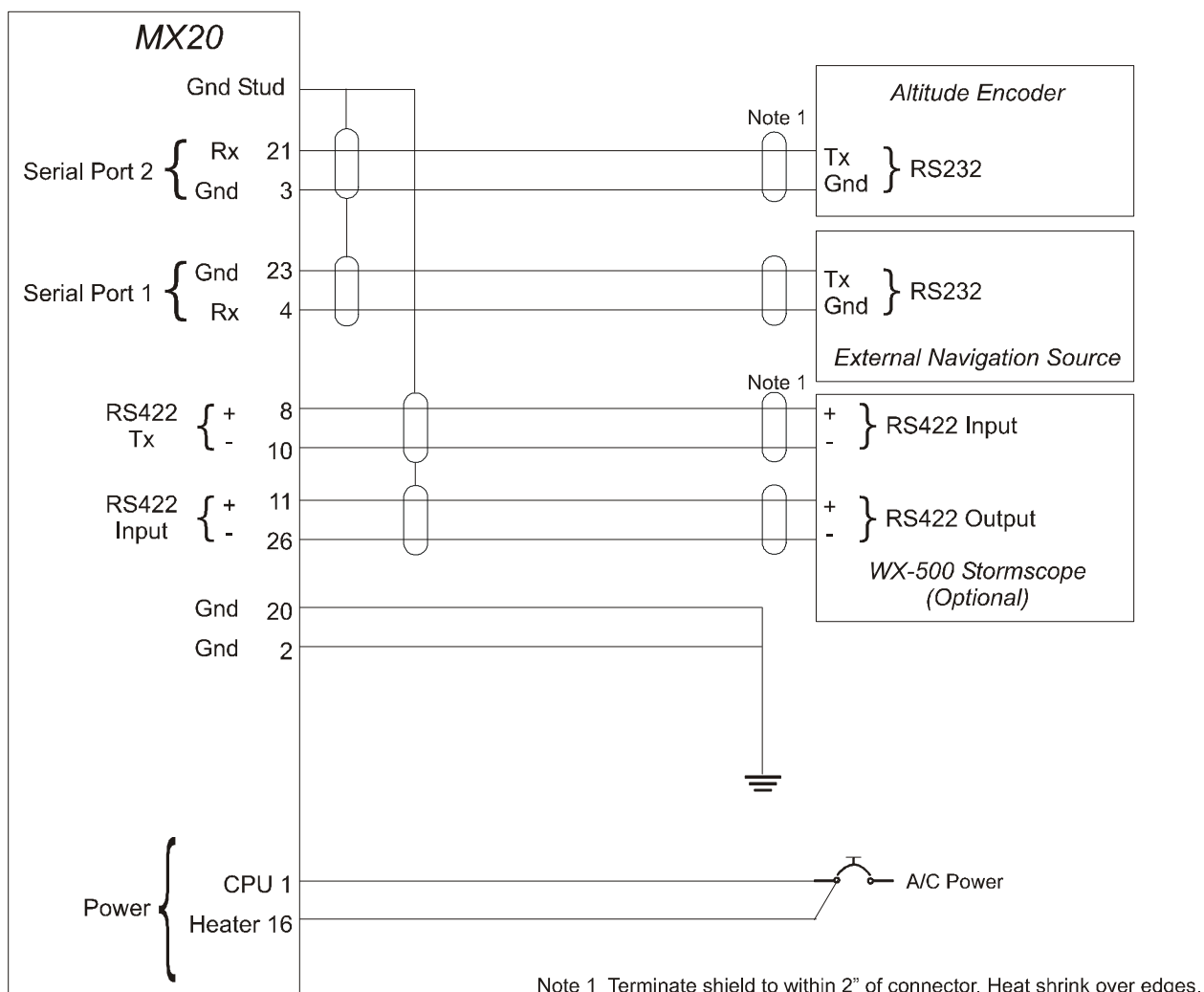
Figure 12 - Sample System Wiring Diagram (No Internal GPS Version)

2.6 WEIGHT AND BALANCE

Weight and balance computation is required after the installation of the MX20. Follow the guidelines as established in AC 43.13-1B, Chapter 10, section 2. Make appropriate entries in the equipment list indicating items added, removed, or relocated along with the date accomplished. Include your name and certificate number in the aircraft records. The following table identifies the weight of the new MX20 equipment.

Table 4 - Unit Weights	
Unit	Weight
MX20 only (with GPS)	4.08 lb. (1.85 kg)
MX20 only (without GPS)	3.92 lb. (1.78 kg)
MX20 mounting tray only	0.73 lb. (0.33 kg)

2.7 CONFIGURING THE MX20

1. Turn on power to the MX20.

2. Immediately after the self-test is complete, press line select keys 1, 4, and 6 in sequence (where 1 is the top line select key, 4 is the fourth key down, and 6 is the lower most line select key).

3. Press the function key until the INST function is present. If INST function is not found, restart the unit. Carefully press line select keys 1, 4, and 6 in sequence. Do not press any other buttons before pressing the 1, 4, 6 line select key sequence.

4. Select the INST function by pressing the smart key directly below the INST label. The Enable/Disable Functions will be the first screen to appear.

2.7.1 ENABLE/DISABLE FUNCTIONS
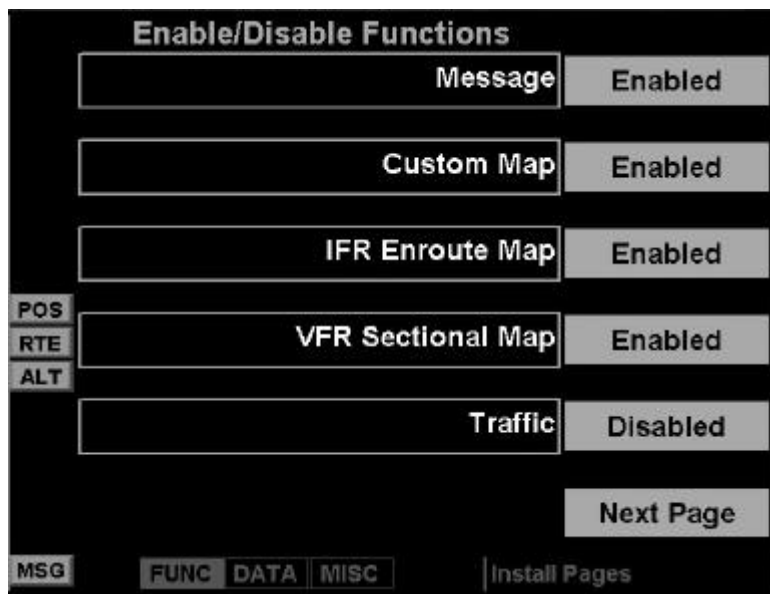
1. Ensure the Enable/Disable Functions page of the MX20 has the desired configuration. Modifications can be made using the line select keys.

   Enable Terrain if an altitude encoder is installed.

   Enable Lightning if WX-500 is installed.

2. Press the Next Page line select key to view additional functions.
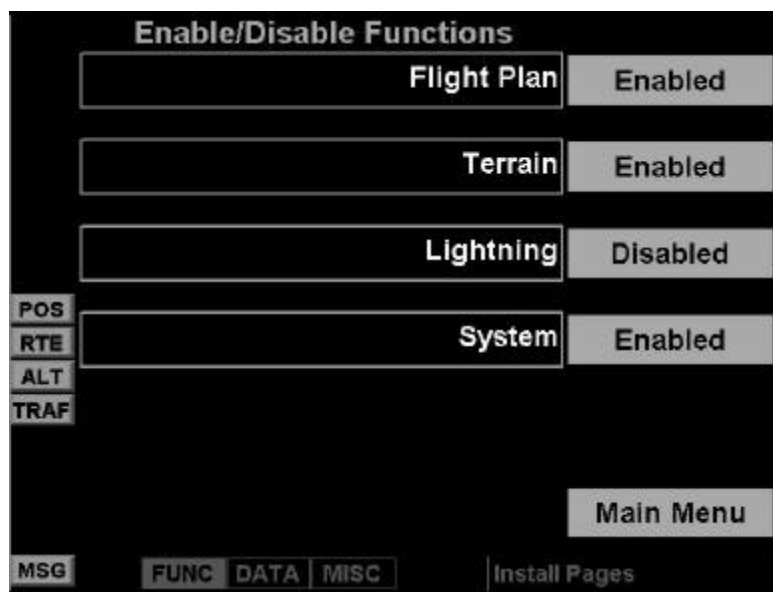
3. A typical installation will have all functions enabled except those noted above based on what hardware is installed in the aircraft.

2.7.2 EXTERNAL DATA SOURCE

1. Press the DATA smart key while still in the INST function.

2. Ensure the External Data Sources page of the MX20 has the desired configuration. Modifications can be made using the line select keys. Port allocations must match how the system is wired. Set port source to None if the hardware is not installed.
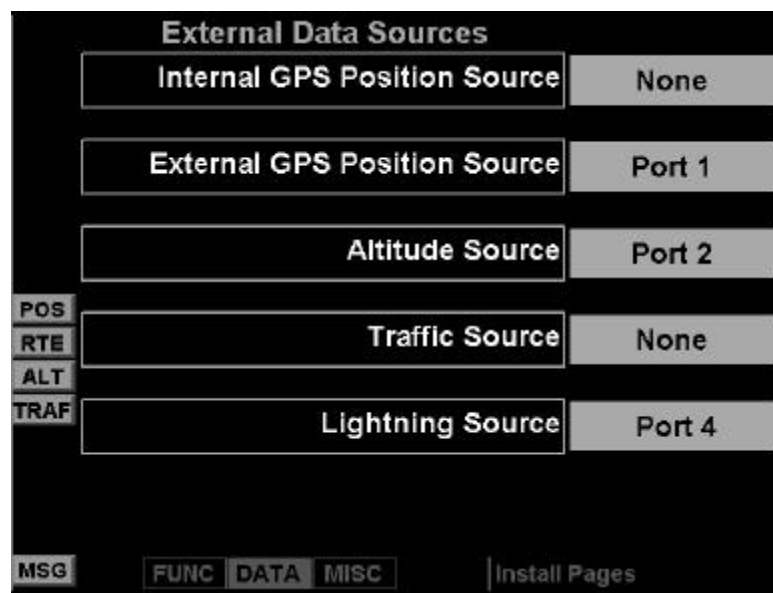
2.7.3 MISCELLANEOUS SETUP OPTIONS

1. Press the MISC smart key while still in the INST function.

2. Ensure the Misc Setup Options page of the MX20 is configured with respect to the aircraft it is being installed in. Modifications can be made using the line select keys.

3. Obtain ICAO address of the aircraft from the FAA only if the UAT/ADS-B system is installed. The ICAO address is a unique 24-bit code assigned to each aircraft. For U.S. registered aircraft, it will be necessary to have a specific address code assigned. These address codes are presently issued by:

    Federal Aviation Administration
    FAA Aircraft Registry
    P.O. Box 25504
    Oklahoma City, OK 73125
    Tel: (405) 945-3116
    Fax: (405) 954-3548

    If the aircraft is registered in a country other than the United States, please contact the local aviation authority of the country in which the aircraft is registered.

4. Enter in Flight ID. (Not required if UAT/ADS-B system is not installed.)

5. Enter in Ownship Symbol (Single Engine, Twin, or Jet).

6. Set the Terrain Clearance Mode to Normal for **all** operations.

7. Demo Mode must be disabled for **all** aircraft installations.

8. Press Enter/Menu to confirm all settings.

9. Turn the MX20 power off **to apply all software setup settings**.

2.8 POST INSTALLATION CHECKOUT

Once the unit is installed, complete the checkout procedure to verify proper operation. Refer to the MX20 Multi-Function Display User's Guide, 560-1026, for operating instructions.

2.8.1 MOUNTING / WIRING CHECK

Verify that all cables are properly secured and shields are connected to the rear of the mounting frame. Check the movement of the flight and engine controls to verify that there is no interference. Ensure wiring is installed in accordance with AC 43.13-1B, Chapter 11.

2.8.2 EXTERNAL DATA SOURCE TESTS

1. Turn on power to the MX20, UAT if installed, and to the external altitude source.

2. Select the Map function via the FN button.

3. Verify ALT data flag is not displayed in the lower left portion of the MX20 display.

4. If the UAT is installed, ensure UAT circuit breaker is closed and that the TRAF data flag is not displayed.

5. With external navigation source off, the following data flags should be present: POS and RTE.

   Notes: The external navigation source must be properly configured prior to this step.

   Direct To sequence must be entered for external navigation source to output POS and RTE.

   If an internal GPS exists, it can also provide a valid position to the MX20.

6. Turn the external navigation source power on. Verify after the navigation source acquires position that POS data flag is not displayed.

7. Create/activate a flight plan on the external navigation source.

8. Verify RTE data flag is not displayed.

9. Flight plan will be displayed on the MFD on the FPL page.

2.8.3 SOFTWARE AND DATABASE TEST

1. Turn on power to the MX20.

2. Verify all self-tests pass on the main startup screen.

3. Verify the expiration on the NavData database.

4. Verify the Terrain and Geography databases are applicable to the area of intended flight (CONUS, Alaska, etc.).

5. Press the MSG smart key and verify that "Unit configured for Special Terrain Mode" is **NOT** displayed. (See normal terrain mode selection under section 2.7.3.)

2.8.4 EMI/RFI TEST

1. This test validates that interference does not exist between the external navigation source and other systems on the aircraft.

2. Ensure the MX20 and external navigation source power is on.

3. Load a flight plan on the external navigation source.

4. While performing the following tests, observe the MX20, external navigation source (signal reception), and the system under test for interference.

   Turn on the transponder (if equipped).

   Turn power on to the NAV unit and tune to a local frequency (VOR/DME).

   Turn power on to any other navigation source.

2.8.5 ALTITUDE TEST

1. Perform the installation and calibration tests in accordance with the altitude source manufacturer's installation manual.

2. Perform a flight check against the aircraft altimeter. Verify readings at ground level and at three additional altitude points.

3. The altitude will be displayed on the bottom right-hand corner of the MFD terrain page.

2.8.6 COMPASS TEST

If the MX20 is located within 4 inches of any compass, the compass will require a compass calibration.

2.8.7 STORMSCOPE INTERFACE TEST

If a BF Goodrich WX-500 Stormscope® sensor has been connected to the MX20, the interface should be verified under LT function on the MX20. Four standard stormscope test screens are available to support system checkout. Refer to the WX-500 Stormscope Installation Manual, P/N 009-11500-001. These test screens are System Data, Self-Test, Noise Monitor, and Strike Test.

3 SPECIFICATIONS

This section includes detailed electrical, physical, environmental, and performance specifications for the MX20.

3.1 MX20 FEATURES

3.1.1 DISPLAY

6" Diagonal, Color AMLCD Display
640x480 Resolution (921,600 RGB Dots)
65,535 Simultaneous Colors
Direct Sunlight Readable
Auto/Manual Dimming

3.1.2 USER INTERFACE

Back-lit, high tactile buttons
Six general purpose "line select keys"
Four general purpose "smart keys"
Dedicated Function and Menu/Enter keys
Front Panel Data-Card Access
Open Software Architecture
Field-Upgradeable Code

3.1.3 EXPANSION/INTERNAL ARCHITECTURE

Open software architecture
Field-Upgradeable software
PC-104/PC-104L expansion bus
Four external high-speed serial I/O ports
Two general purpose input flags

3.1.4 POSITION SOURCE

Primary - External GPS or Loran via RS-232 serial input
Optional internal GPS

3.1.5 ELECTRICAL

Input Voltage ....10 VDC to 40 VDC, reverse polarity protected
Input Current ....2.0 A typical, 3 A Max without heater at 13.75 V
3.0 A typical, 4 A Max with heater at 13.75 V
1 A typical, 1.5 A Max without heater at 27.5 V
1.5 A typical, 2 A Max with heater at 27.5 V

Input Power ....28 watts typical (13.75 V) – no heater
42 watts typical (13.75 V) – heater on
Heater Switch Point ....Below 10°C, heater on

3.1.6 AVIONICS OUTPUTS

Serial Ports...3 High Speed RS232
1 High Speed RS422

3.1.7 AVIONICS INPUTS

Serial Ports...3 High Speed RS232
1 High Speed RS422
Discrete Inputs ....2 General Purpose

3.1.8 SERIAL INTERFACE

Position Source ....Apollo GX50/55/60/65 or internal
Apollo SL50/60
Trimble 2000, 2000 Approach, 2000 Approach Plus,
2101, 2101 I/O, 2101 I/O Plus
Garmin GNC 250 XL and equivalent
Bendix/King KLN 90B TSO and equivalent

3.1.9 PHYSICAL SPECIFICATIONS

Height ....5.00 inches (12.7 cm)
Width...6.25 inches (15.88 cm)
Depth...8.00 inches (20.3 cm)
Weight (without mounting frame).............3.92 pounds (1.76 kg) (without internal GPS)
4.08 pounds (1.85 kg) (with internal GPS)
(mounting frame only - no connectors) .....0.73 pounds (0.33 kg)

3.1.10 ENVIRONMENTAL SPECIFICATIONS

Operating Temperature.............................-20°C to +55°C
Storage Temperature................................-55°C to +85°C
Temperature Variation.............................2°C per minute
Humidity...95% at 50°C
Maximum altitude....................................35,000 ft
Cooling ....Not Required

3.1.11 TSO AUTHORIZATIONS

TSO-C110a (when connected to BFG WX-500)
TSO-C113

3.1.12 INTERNAL GPS RECEIVER PERFORMANCE

Number of channels 8

Frequency..1575.42 MHz L1, C/A code

Sensitivity (acquisition)............................-135 dBm

Sensitivity (drop lock).............................-142 dBm

Dynamic range..> 20 dB

Lat/Lon position accuracy.......................15 meters RMS typical
25 meters, SEP, without SA
100 meters 2DRMS with SA

Velocity...1000 knots maximum

Acceleration...4G maximum

TTFF (time to first fix)............................25 seconds typical with current almanac, position, time, and ephemeris
55 seconds typical with current almanac, position, and time

Reacquisition ....2.5 seconds typical

Position update interval...........................1 second typical

Datum..WGS-84

3.2 REAR CONNECTOR PINOUTS

Table 5 - MX20 Rear Panel Connector Pinout			
Pin #	**I/O**	**Name**	**Comment**
1	I	Power +	Main Aircraft Power Input (+10 to +30 VDC)
2	I	Power ground	Main Aircraft Power Ground
3	I	Port 2 GND	RS-232
4	I	Port 1 IN	RS-232
5	O	Port 1 OUT	RS-232
6	O	Port 3 OUT	RS-232
7	I	Port 3 IN	RS-232
8	O	Port 4 OUT +	RS-422
9	-	NC	Unused
10	O	Port 4 OUT -	RS-422
11	I	Port 4 IN +	RS-422
12	I	Power ground	
13	-	NC	Unused
14	I	Input Flag 1	Discrete Input (Internally Pulled Up)
15	I	Input Flag 3	Discrete Input (Internally Pulled Up)
16	I	Heater Power +	Auxiliary Heater Input (+10 to +30 VDC)
17	O	1 PPS OUT +	1 Pulse Per Second Output (RS422 Level)
18	-	NC	Unused
19	O	1 PPS OUT -	1 Pulse Per Second Output (RS422 Level)
20	I	Power ground	
21	I	Port 2 IN	Port 2 RS-232 RxD
22	O	Port 2 OUT	Port 2 RS-232 TxD
23	I	Port 1 GND	RS-232
24	O	Keyboard Supply (+5)	NC In Aircraft Install
25	I	Port 3 GND	RS-232
26	I	Port 4 IN -	Port 4 RS-422 RxD -
27	I	Keyboard Ground	NC In Aircraft Install
28	I	Keyboard Data	NC In Aircraft Install
29	I	Keyboard Clock	NC In Aircraft Install
30	-	NC	Unused
31	-	NC	Unused
32	-	NC	Unused
33	I	Input Flag 2	Discrete Input (Internally Pulled Up)
34	I	Input Flag 4	Discrete Input (Internally Pulled Up)
35	-	NC	Unused
36	I	External Power Switch	External Power Switch (Gnd to Turn On)
37	-	NC	Unused
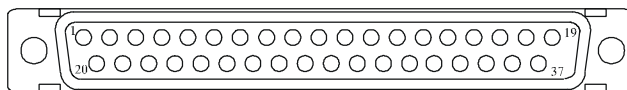
Viewed from rear of unit

4 TROUBLESHOOTING

This appendix provides information to assist troubleshooting if problems occur after completing the installation. Use Table 6 to assist in troubleshooting.

Table 6 - Troubleshooting Guide		
Problem	**Cause**	**Solution**
Unit does not power up – blank screen.	1. Improper wiring; circuit breaker open. 2. Unit intensity turned down. 3. Unit is cold. 4. Data card improperly installed.	1. Ensure power is properly wired to the MX20 and the circuit breaker is closed. 2. Ensure that unit is not in manual intensity control mode with the intensity turned down. 3. If ambient temperature is below 10°C, allow unit to preheat for up to 60 seconds. 4. Ensure that the data card is fully inserted in the front bezel (It should be flush with the ejector button).
Unit fails during power-on self-test (POST).	Data card improperly installed.	Ensure that the data card is fully inserted in the front bezel (It should be flush with the ejector button).
INST function not shown in install mode.	1. Improper key sequence entered. 2. Too many keys pressed in key sequence. 3. Cycle through functions not completed.	1. Ensure that the proper installation key sequence is carefully entered after the power on self-test is complete. 2. Ensure that no other keys are pressed prior to entering the sequence. 3. Cycle through the available functions by pressing the FN key – INST function is on last available function page.
Unit shows POS data flag.	1. Data port information not correct. 2. Antenna cables improperly installed. 3. Antenna is improperly installed. 4. Waypoint not selected as the current destination. 5. Position source not configured on appropriate port. 6. External GPS not properly configured. 7. RF interference.	1. Ensure that the data port configuration is correct and matches how the unit is wired for the position source. 2. Ensure that the GPS antenna cables are correctly installed on the external GPS and the internal GPS (if equipped). 3. Ensure that the GPS antenna is correctly installed on top of aircraft and aircraft is clear of hangers, buildings and trees. 4. If a GX/SL series is used as the position source, ensure that a waypoint is selected as the current destination (Nav Flagged is not shown on primary nav

Table 6 - Troubleshooting Guide		
Problem	**Cause**	**Solution**
		page). 5. If a GX/SL series is used as the position source, ensure that it is configured to output serial data (MOV MAP) on the appropriate port. 6. If other compatible external GPS is used, ensure it is configured to output serial position data on the appropriate lines. 7. Ensure no RF interference at 1575 MHz from VHF Comm antenna – add 1575 MHz notch filter in Comm coax; Fix or replace Comm; Disconnect the ELT antenna coax to check.
Unit shows RTE data flag.	External position source does not have active route engaged.	Ensure that the external position source has an active route engaged.
Unit shows ALT data flag.	1. Data port configuration incorrect. 2. Serial altitude encoder not powered up; not functioning properly.	1. Ensure that the data port configuration is correct and matches how the unit is wired for the serial altitude source. 2. Ensure that serial altitude encoder is powered up and functioning properly.
Unit shows LT data flag.	1. Terrain database incorrect. 2. Invalid altitude supplied to unit.	1. Ensure the unit has the appropriate terrain database loaded for the area of operation. The terrain database is indicated on the power-up and system status pages of the MX20. 2. Ensure that valid altitude is being supplied to the unit (an ALT data flag should not be present).
Unit shows DEMO data flag.	Demo mode enabled.	Ensure that demo mode is not enabled in the install pages.
Unit posts message indicating 'Special' terrain clearance mode after power-up.	Incorrect terrain clearance mode entered.	1. This is normal for special 'Capstone' support. 2. General aviation usage should have the terrain mode set to 'Normal' in the install pages.

4.1 CONTACTING THE FACTORY FOR ASSISTANCE

If the MX20 fails to operate despite troubleshooting efforts, contact the UPS Aviation Technologies factory for assistance.

UPS Aviation Technologies, Inc.
2345 Turner Rd. SE
Salem, Oregon 97302
USA

Phone (503) 581-8101 or 1-800-525-6726

http://www.upsat.com

Be prepared to offer the following information about the installation:
- Installation configuration (accessories, antenna, ...)
- Model number, part number with mod levels, and serial number
- Software version
- Description of problem
- Efforts made to isolate the problem

NOTES

5 CONTINUED AIRWORTHINESS INSTRUCTIONS

The MX20 is designed to not require any regular maintenance except as included in this section:

5.1 EQUIPMENT CALIBRATION

The MX20 design requires no adjustments or calibration to be made.

5.2 CLEANING THE FRONT PANEL

The front bezel, keypad, and display can be cleaned with a soft cotton cloth dampened with clean water. DO NOT use any chemical-cleaning agents. Care should be taken to avoid scratching the surface of the display.

5.3 LITHIUM BATTERY REPLACEMENT

The internal keep-alive battery will require replacement after 5 years of service. The Li battery is only included in MX units with internal GPS 430-0270-000. The effect of battery failure is a loss of the real time clock in the GPS receiver. The unit will still work with loss of battery power; however, GPS acquisition may take considerably longer time (20 minutes). There is no hazard associated with such a failure.

To replace the battery, the MX20 must be removed from the aircraft and serviced by an appropriately rated UPS AT service center. If the aircraft is to fly without the unit installed, placard the aircraft accordingly.

Note: The battery is to be replaced ONLY with UPS AT part number 148-0052-00, or a UPS AT approved equivalent.

5.4 ALTITUDE ENCODER

In this VFR non-essential system, it is recommended that the altitude encoder be calibrated every 24 months. Refer to the manufacturer's installation and calibration manual.

5.5 MANUALS

Incorporate operational test and troubleshooting guides into Aircraft Maintenance manuals. Update the wiring diagram manual and equipment list as necessary. Add each component to the reliability program as necessary.

NOTES

6 ENVIRONMENTAL QUALIFICATIONS

The MX20 has been tested to the following environmental categories per procedures defined in RTCA/DO-160D.

Environmental Qualification Form			

Model: MX20
Part No: 430-6050-4xx
TSO No: TSO-C129a Class A1
			Manufacturer:
			  UPS Aviation Technologies Inc.
			  2345 Turner Road SE
			  Salem, Oregon 97302

Conditions	Section	Description of Conducted Tests	

Temperature and Altitude
  Operating Temp
  Short Time High Temperature
  Ground Survival Temperature
  In-flight Loss of Cooling
  Altitude
  Decompression
  Overpressure
	4.0
	
	4.5.4
	4.6.1
	4.6.2
	4.6.3
		Equipment tested to Category A1 and C1 with
		-20°C to +55°C
		+ 70°C
		-55°C to +85°C
		No cooling required
		Equipment tested to 35,000 feet
		Equipment tested 8K to 35K in < 15 seconds
		Equipment tested for overpressure	

Temperature Variation	5.0	Equipment tested to Category C, 2°C/minute	
Humidity	6.0	Equipment tested to Category A, standard humidity environment	
Operational Shocks and Crash Safety	7	Equipment tested to Category B5R for both operational and crash safety shocks. (Equipment operated normally after the crash safety shocks.)	
Vibration	8.0	Standard vibration S curves (M and B)	
Explosion Proofness	9.0	Equipment identified as Category X, no test required	
Waterproofness	10.0	Equipment identified as Category X, no test required	
Fluids Susceptibility	11.0	Equipment identified as Category X, no test required	
Sand and Dust	12.0	Equipment identified as Category X, no test required	
Fungus Resistance	13.0	Equipment identified as Category X, no test required	
Salt Spray	14.0	Equipment identified as Category X, no test required	
Magnetic Effect	15.0	Equipment is Class Z, < 0.3 meters	
Power Input	16.0	Equipment tested to Category B for 14 and 28 VDC	
Voltage Spike	17.0	Equipment tested to Category A	
Audio Frequency Conducted Susceptibility - Power Inputs	18.0	Equipment tested to Category B	
Induced Signal Susceptibility	19.0	Equipment tested to Category C, Z	
Radio Frequency Susceptibility (Radiated and Conducted)	20	Equipment tested to Category U (Conducted) Equipment tested to Category V (Radiated)	
Emission of Radio Frequency Energy	21	Equipment tested to Category M	
Lightning Induced Transient Susceptibility	22.0	Equipment tested to Category A3 and B2	
Lightning Direct Effects	23.0	Equipment identified as Category X, no test required	
Icing	24.0	Equipment identified as Category X, no test required	
Electrostatic Discharge	25.0	Equipment tested to Category A	
Remarks:			

NOTES

APPENDIX A – I/O SPECIFICATIONS

This appendix includes the RS-232 serial port interface specifications.

MOVING MAP OUTPUT

The format of the moving map data output is as follows. Definitions of the output data is included in Table 7 and Table 9. A sample output message is included in Figure 13.

Baud rate: 9600
Data bits: 8
Stop bits: 1
Parity: ....none
Output rate: ....approx. 1 seconds
Message length: ....variable, approx. 83 to 484 characters

The serial output messages are in the following format.

<STX><id><data><it><id><data><it>...<id><data><it><ETX>

<STX> ....ASCII "start of text" character (1 byte, 02h)
<id> ....item designator (1 byte, from following table)
<data> ....item data (format listed in following table)
<it> ....item terminator (1 byte, 0Dh)
<ETX> ....ASCII "end of text" character (1 byte, 03h)

ID	Data Format	Length	Description
Table 7 - Moving Map ASCII Navigation Data			
A	sddmmhh	9	Present latitude s = sign: N for north, S for south dd = degrees mm = minutes hh = hundredths of minutes
B	sdddmmhh	10	Present longitude s = sign: E for east, W for west ddd = degrees mm = minutes hh = hundredths of minutes
C	ddd	3	Track (magnetic): ddd = degrees
D	ddd	3	Ground speed: ddd = knots
E	ddddd	5	Distance to active waypoint: ddddd = nm x 10
G	sdddd	5	Cross track error: s = sign: R for right, L for left of course dddd = distance off course, hundredths of nm
I	dddd	4	Desired track (magnetic): dddd = degrees x 10
K	ddd[dd]	3 to 5	Active waypoint identifier:

Table 7 - Moving Map ASCII Navigation Data			
ID	**Data Format**	**Length**	**Description**
			ddd[dd] = ASCII waypoint identifier
L	dddd	4	Bearing to active waypoint (magnetic): dddd = degrees x 10

Q	sddd	4	Magnetic variation:
			   s = sign: E for east, W for west
			   ddd = degrees x 10

T	---A-----	9	Warnings: The 4th character will be an "A" when the navigation data is flagged, otherwise, all characters will be dashed. All other navigation data will be dashed when it is flagged.

BINARY NEAREST LIST DATA (WHEN EXTENDED DATA IS ENABLED ONLY)

The nearest waypoints lists are sent one waypoint per data transmission set. The lists are sent in the following order:

- LFAC
- VOR
- NDB
- INT
- User

There is a maximum of twenty waypoints per type. The waypoints are a maximum of 600 nm from the current position. The waypoints are order by distance from current position nearest to farthest. The maximum time to send all lists is 100 second. Each list is updated just prior to the first waypoint in the list being sent. If a list is empty a shorter record will be sent with the List Item Number set to 0xFF.

Table 8 - Nearest Waypoint List Data		
Byte	**Format**	**Description**
1	Z	'Z' **Item Designator**
2	sddddddd	**List Item Number:** Packed, unsigned binary values s = 1 End of list, 0 all other ddddddd = 1 – 20 list waypoint index sddddddd = 0xFF List Type is EMPTY (**BYTE 4 terminate Item**)
3	t	**Waypoint Type**: t = {a (airport) || v (VOR) || n (NDB) || i (INT) || u (USER)}
4	Cr	'\r' **Item Terminator** <0x0d> (**ONLY IF BYTE 3 = OxFF**)
4-8	ddddd	**ASCII Waypoint Identifier**
9 10	sddddddd xxmmmmmm	**Latitude of waypoint.** Packed, unsigned binary values for degrees, minutes and hundredths of minutes.

**Table 8 - Nearest Waypoint List Data**		
Byte	**Format**	**Description**
11	xhhhhhhh	s = 0 North latitude, 1 South latitude x = undefined ddddddd = Latitude degrees mmmmmm = Latitude minutes hhhhhhh = Latitude hundredths of minutes
12 13 14 15	sxxxxxxx ddddddd xxmmmmmm xhhhhhhh	**Longitude of waypoint.** Packed, unsigned binary values for degrees, minutes and hundredths of minutes. s = 0 East longitude, 1 West longitude x = undefined ddddddd = Longitude degrees mmmmmm = Longitude minutes hhhhhhh = Longitude hundredths of minutes
16	Cr	'\r' **Item Terminator** <0x0d>

**Table 9 - Moving Map Binary Route Data**		
Byte	**Data Format**	**Description**
1	w	Item designator
2-3	dd	Current waypoint number in ASCII (01h to 20h)

4	xiannnnn	Sequence number
		  x = undefined
		  i = 1 if last waypoint
		  a = 1 if active waypoint
		  nnnnn = unsigned binary waypoint number

5-9	ddddd	ASCII waypoint identifier

10
11
12
	sddddddd
	xxmmmmmm
	xhhhhhhh
		Waypoint latitude - packed, unsigned binary
		  s = sign: 0 for north, 1 for south
		  ddddddd = degrees
		  mmmmmm = minutes
		  hhhhhhh = hundredths of minutes
		  x = undefined

13
14
15
16
	sxxxxxxx
	sddddddd
	xxmmmmmm
	xhhhhhhh
		Waypoint longitude
		  s = sign: 0 for east, 1 for west
		  ddddddd = degrees
		  mmmmmm = minutes
		  hhhhhhh = hundredths of minutes
		  x = undefined

Table 9 - Moving Map Binary Route Data		
Byte	**Data Format**	**Description**

17
18
	nnnnnnnn
	nnnnnnnn
		Magnetic variation at waypoint
		  LS byte (msbit...lsbit)
		  MS byte (msbit...lsbit)
		Two's complement binary in sixteenths of degrees, easterly variation is positive.

19	<CR>	ASCII carriage return (0Dh)

FLIGHT PLAN WAYPOINT TYPES (WHEN EXTENDED DATA IS ENABLED ONLY)

The following data is only transmitted when preceded by flight plan data. There is one character per flight plan waypoint transmitted.

Table 10 - Flight Plan Waypoint Type			
Id	**Item Format**	**Len**	**Description**

t	nnn…	1-21	n = { a (airport) ‖
			       v (VOR) ‖
			       n (NDB) ‖
			       i (intersection) ‖
			       u (user) ‖
			       p (parallel track) ‖
			       d (direct to) ‖
			       F (FAF) ‖
			       I (IAF) ‖
			       H (MAHP) ‖
			       A (IFAF) ‖
			       P (undefined approach waypoint type) }

```
Example Moving Map Data Output (Extended Data Disabled)
     AN 34 1570              34°15.70' latitude
     BW 118 4390             118°43.90' longitude
     C306                    306° track angle
     D210                    210 knots
     E02682                  268.2nm to waypoint
     GR0006                  0.6nm right of course
     I3059                   305.9° desired track
     KSFO                    SFO waypoint ident
     L3058                   305.8° bearing to waypoint
     QE140                   14.0° east magnetic variation
     T---------              No alarms, data not flagged
     <binary data>          From Table 9
```

Figure 13 - Moving Map Data Output (Extended Data Disabled)

```
Example Moving Map Data Output (Extended Data Enabled)
     AN 34 1570              34°15.70' latitude
     BW 118 4390             118°43.90' longitude
     C306                    306° track angle
     D210                    210 knots
     E02682                  268.2nm to waypoint
     GR0006                  0.6nm right of course
     I3059                   305.9° desired track
     KSFO                    SFO waypoint ident
     L3058                   305.8° bearing to waypoint
     QE140                   14.0° east magnetic variation
     T---------              No alarms, data not flagged
     <binary data>          From Table 7
     a—O--F                  Approach Enabled Off, Active Off, Message On, Parallel Track
                               Off, Hold Off, and From/To is FROM
     cvR001                  CDI Valid, Needle Right, Deflection 001°
     vC000                   VDI Valid, Needle Centered, Deflection is 000°
     <binary data>          From Table 9
     tda                     Flight Plan Waypoint Type data, direct-to, airport type
```

Figure 14 - Moving Map Data Output (Extended Data Enabled)

ALTITUDE ENCODER/CONVERTER INPUT

The format of the altitude input is as follows. Definition of the input message is included in Table 11. Several sample messages are illustrated in Figure 15.

Baud rate: 1200
Data bits: 8
Stop bits: 1
Parity: ....none
Expected input rate: ....approx. 1 second
Message length: ....17 characters

Byte	Data Format	Description
	Table 11 - Altitude Input Data	

Byte	Data Format	Description
1	"#"	ASCII "#" (023h)
2	"A"	ASCII "A" (041h)
3	"L"	ASCII "L" (04Ch)
4	" "	ASCII space (020h)
5	"+" or "-"	Altitude sign: ASCII "+" or "-" (02Bh or 02Dh)
6-10	ddddd	Altitude in feet, right justified with leading zeros
11	"T"	ASCII "T" (054h)
12	"+" or "-"	Temperature sign: ASCII "+" or "-" (02Bh or 02Dh)
13-14	dd	Internal altimeter temperature
15-16	dd	Checksum of bytes 1 through 14, computed in hex, output in ASCII format (i.e., "FA" hex)
17	<CR>	ASCII carriage return (0Dh)

The altitude input can decode several status or error codes. These codes would be in place of the altitude data in characters 5 - 10 as follows.

"-09980"..Heater not ready: expected during encoder warm-up or if there is a loss of signal from the encoder.
"-09981"..Possible hardware problem: expected from encoder indicating a temperature greater than 55°C or if data is invalid.
"-09982"..Altitude out of range: expected from the encoder indicating that the altitude is outside specified range of the encoder.
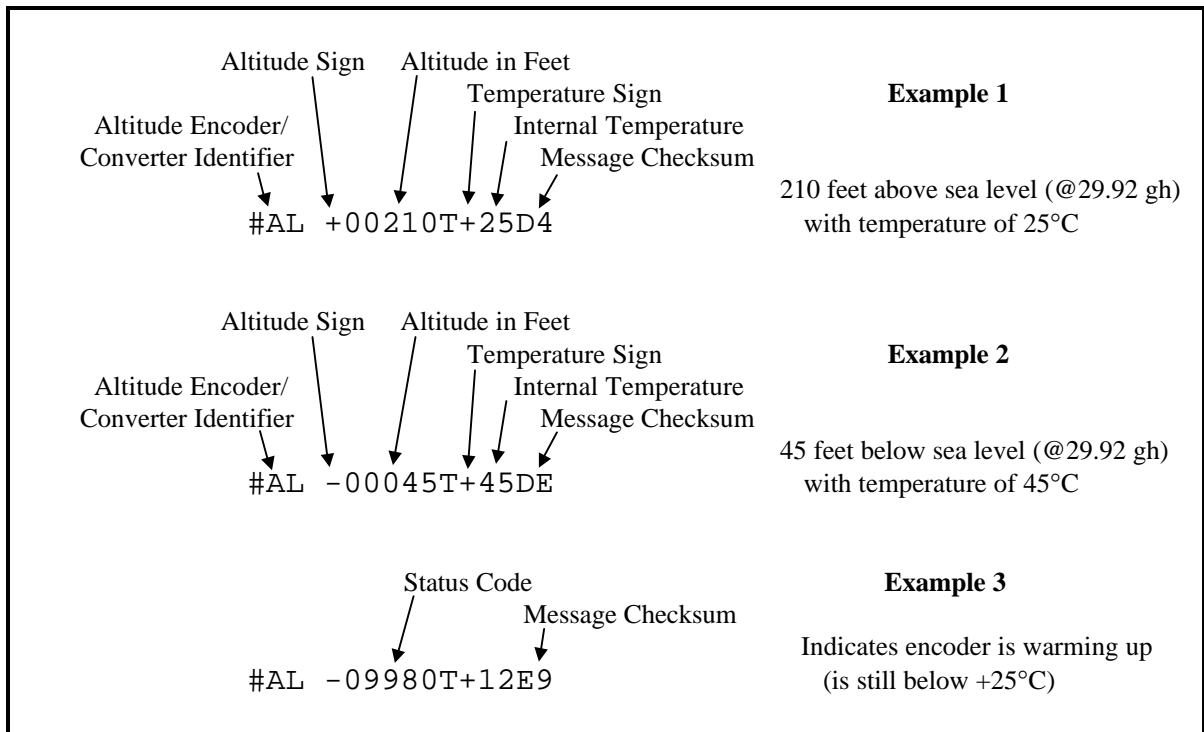
Figure 15 - Altitude Data Input

STORMSCOPE OUTPUTS

The WX-500 is the only stormscope that the MX20 MFD interfaces with. It can be connected to RS-422 or RS-232.

RS-232
Connection	TX	J3-20
	RX	J3-8
	RS-232_GND	J2-5
Cable	Twisted shielded triad 24 AWG wire	
Voltage	Logic 0 (space) Min: +5V, Max: +15V	
	Logic 1 (mark) Min: -15V, Max: -5V	
Baud Rate	9600	
Load Impedance	3KO Min.	

RS-422
Connection	TX+	J3-25, TX- J3-13
	RX+	J3-24, RX- J3-12
	GND	CASE_GND
Cable	Twisted shielded pair 22 AWG	
Voltage	Logic 0 (space) Min (A-B): +2V, Max (A-B): +6V	
	Logic 1 (mark) Min (A-B): -6V, Max (A-B): -2V	
Baud Rate	9600	
Load Impedance	3KO Min.	

NOTES

UPS Aviation TechnologiesSM
A subsidiary of United Parcel Service